

The documentation and process conversion measures necessary to comply with this revision shall be completed by 13 June 2003.

MIL-PRF-19500/544E
13 March 2003
SUPERSEDING
MIL-PRF-19500/544D
27 July 2001

PERFORMANCE SPECIFICATION

SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, POWER
TYPES 2N5152, 2N5154, 2N5152L, 2N5154L, 2N5152U3, 2N5154U3
JAN, JANTX, JANTXV, JANS, JANHC, AND JANKC

This specification is approved for use by all Departments
and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the performance requirements for NPN, silicon, power transistors for use in high-speed power-switching applications. Four levels of product assurance are provided for each encapsulated device type and two levels of product assurance are provided for each unencapsulated device type as specified in MIL-PRF-19500.

1.2 Physical dimensions. Figure 1 (similar to T0-5 and T0-39), figures 2, 3, and 4 (die dimensions), and figure 5 (U3).

1.3 Maximum ratings.

Type	P_T $T_A = +25^\circ\text{C}$	P_T $T_C = +25^\circ\text{C}$	V_{CBO}	V_{CEO}	V_{EBO}	I_C	I_C (1)	Reverse pulse (2) energy	Safe operating area	T_{stg} and T_J
	<u>W</u>	<u>W</u>	<u>V dc</u>	<u>V dc</u>	<u>V dc</u>	<u>A dc</u>	<u>A dc</u>	<u>mJ</u>		<u>°C</u>
2N5152, L	1 (3)	11.8 (4)	100	80	5.5	2	10	15	See figure 6	-65 to +200
2N5154, L	1 (3)	11.8 (4)	100	80	5.5	2	10	15		-65 to +200
2N5152U3	1.16 (5)	100 (6)	100	80	5.5	2	10	15	See figure 6	-65 to +200
2N5154U3	1.16 (5)	100 (6)	100	80	5.5	2	10	15		-65 to +200

- (1) This value applies for $P_w \leq 8.3$ ms, duty cycle $\leq 1\%$
- (2) This rating is based on the capability of the transistors to operate safely in the unclamped inductive load energy test circuit of figure 7.
- (3) Derate linearly $5.7 \text{ mW}/^\circ\text{C}$ for $T_A > +25^\circ\text{C}$
- (4) Derate linearly $66.7 \text{ mW}/^\circ\text{C}$ for $T_C > +25^\circ\text{C}$
- (5) Derate linearly $6.67 \text{ mW}/^\circ\text{C}$ for $T_A > +25^\circ\text{C}$
- (6) Derate linearly $571 \text{ mW}/^\circ\text{C}$ for $T_C > +25^\circ\text{C}$

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Defense Supply Center Columbus, ATTN: DSCC-VAC, Post Office Box 3990, Columbus, OH 43216-5000, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

FSC 5961

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1.4 Primary electrical characteristics at $T_C = +25^\circ\text{C}$.

Limits	h_{FE2} (1) $V_{CE} = 5\text{ V}$ $I_C = 2.5\text{ A}$		$ h_{fe} $ $V_{CE} = 5\text{ V}$ $I_C = 500\text{ mA dc}$		$V_{BE(sat)2}$ (1) $I_C = 5\text{ A dc}$ $I_B = 500\text{ mA dc}$	$V_{CE(sat)2}$ (1) $I_C = 5\text{ A dc}$ $I_B = 500\text{ mA dc}$	C_{obo} $V_{CB} = 10\text{ V dc}$ $I_E = 0$ $f = 1\text{ MHz}$	$R_{\theta JA}$	$R_{\theta JC}$
	2N5152 (2)	2N5154 (2)	2N5152 (2)	2N5154 (2)					
Min	30	70	6	7	<u>Vdc</u>	<u>Vdc</u>	<u>pF</u>	<u>°C/W</u>	<u>°C/W</u>
Max (TO-5, TO-39)	90	200			2.2	1.5	250	175	15
Max (U3)	90	200			2.2	1.5	250	150	1.75

(1) Pulsed see 4.5.1.

(2) The limits specified apply to all package outlines unless otherwise stated.

2 APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in section 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATION

DEPARTMENT OF DEFENSE

MIL-PRF-19500 - Semiconductor Devices, General Specification for.

STANDARD

DEPARTMENT OF DEFENSE

MIL-STD-750 - Test Methods for Semiconductor Devices.

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Document Automation and Production Services (DAPS), Building 4D (DPM-DODSSP), 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein, the text of this specification takes precedence. Nothing in this specification, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

Symbol 11	Dimensions				Notes
	Inches		Millimeters		
	Min	Max	Min	Max	
CD	.305	.335	7.75	8.51	6
CH	.240	.260	6.10	6.60	
HD	.335	.370	8.51	9.40	
LC	.200 TP		5.08 TP		7
LD	.016	.021	0.41	0.53	8, 9
LL	.500	.750	12.70	19.05	8, 9, 13
LU	.016	.019	0.041	0.48	8, 9
L ₁		.050		1.27	8, 9
L ₂	.250		6.35		8, 9
Q		.050		1.27	6
TL	.029	.045	0.74	1.14	4, 5
TW	.028	.034	0.71	0.86	3
r		.010		0.25	11
α	45° TP		45° TP		7
P	.100		2.54		
Notes	1, 2, 10, 12, 14				

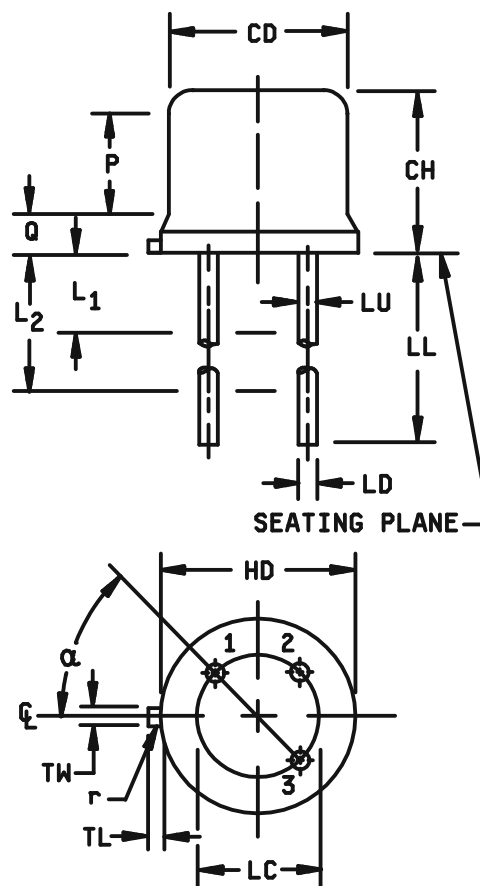


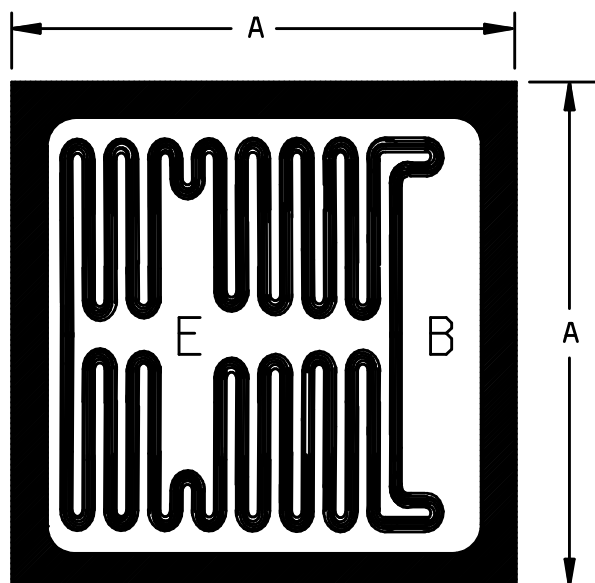
FIGURE 1. Physical dimensions (similar to TO – 5 and TO-39).

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Beyond r (radius) maximum, TW shall be held for a minimum length of .011 inches (0.28 mm).
4. TL measured from maximum HD.
5. Outline in this zone is not controlled.
6. CD shall not vary more than .010 inches (0.25 mm) in zone P. This zone is controlled for automatic handling.
7. Leads at gauge plane .054 +.001 -.000 inch (1.37 +0.03 -0.00 mm) below seating plane shall be within .007 inch (0.18 mm) radius of true position (TP) at maximum material condition (MMC) relative to tab at MMC. The device may be measured by direct methods or by gauge.
8. LU applies between L_1 and L_2 . Dimension LD applies between L_2 and L minimum. Diameter is uncontrolled in L_1 and beyond LL minimum.
9. All three leads.
10. The collector shall be internally connected to the case.
11. r (radius) applies to both inside corners of tab.
12. In accordance with ASME Y14.5M, diameters are equivalent to \varnothing x symbology.
13. For "L" suffix devices, dimension LL is 1.50 (38.10 mm) minimum, 1.75 (19.05 mm) maximum.
14. Lead designation, depending on device type, shall be as follows:

Lead number	TO-39	TO-5
1	Emitter	Emitter
2	Base	Base
3	Collector	Collector

FIGURE 1. Physical dimensions (similar to TO – 5 and TO-39) - Continued.

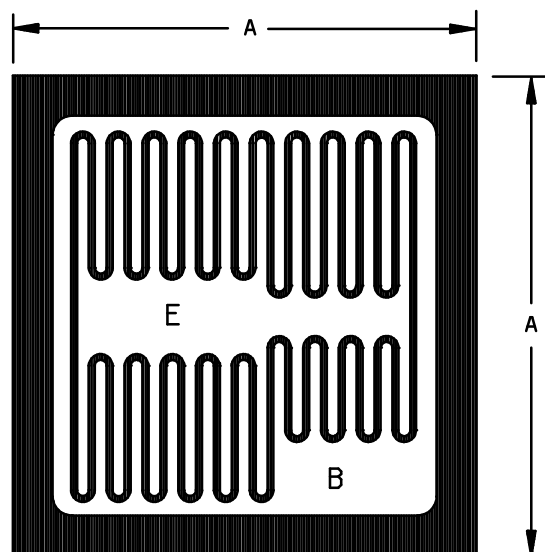


Dimensions				
LTR	Inches		Millimeters	
	Min	Max	Min	Max
A	.117	.127	2.97	3.23

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Unless otherwise specified, tolerance is $\pm .005$ (0.13 mm).
4. The physical characteristics of the die are;
 - Thickness: .008 (0.20 mm) to .012 (0.30 mm), tolerance is $\pm .005$ (0.13 mm).
 - Top metal: Aluminum, 40,000 Å minimum, 50,000 Å nominal.
 - Back metal: Gold 2,500 Å minimum, 3,000 Å nominal.
 - Back side: Collector.
 - Bonding pad: B = .015 (0.38 mm) x .0072 (0.183).
 - E = .015 (0.38 mm) x .0060 (0.152).

FIGURE 2. JANHCA and JANKCA die dimensions.

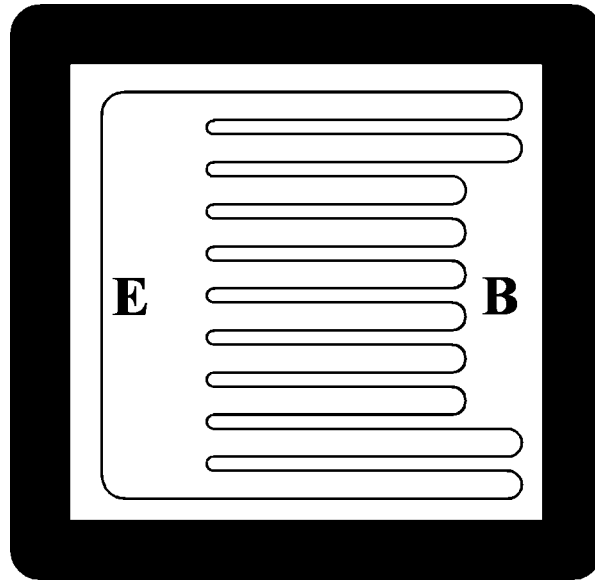


Dimensions				
LTR	Inches		Millimeters	
	Min	Max	Min	Max
A	.095	.105	2.41	2.66

NOTES:

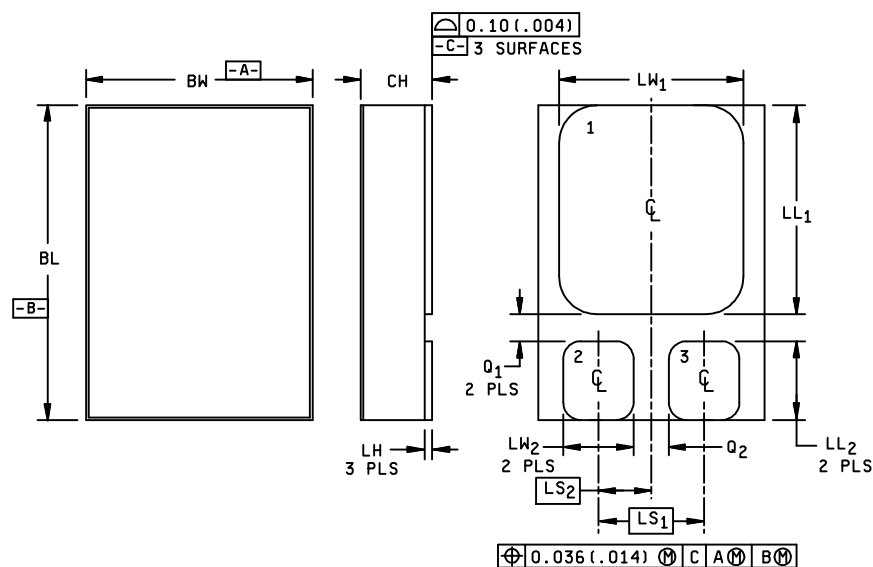
1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Unless otherwise specified, tolerance is ± 0.005 (0.13 mm).
4. The physical characteristics of the die are;
5. Thickness: .0078 (0.198 mm) nominal, tolerance is ± 0.005 (0.13 mm).
 Top metal: Aluminum, 25,000 Å minimum, 33,000 Å nominal.
 Back metal: Gold 1,500 Å minimum, 2,500 Å nominal.
 Back side: Collector.
 Bonding pad: .012 (0.305 mm) min. x .030 (0.761 mm) minimum.

FIGURE 3. JANHCB and JANKCB die dimensions.



- | | |
|------------------|---|
| 1. Die size. | .120 inches (3.05 mm) x .120 inches (3.05 mm) \pm .002 inches (\pm 0.05 mm). |
| 2. Die thickness | .010 inches (0.25 mm) \pm .0015 inches nominal (\pm 0.04 mm). |
| 3. Top metal | Aluminum, 30,000Å minimum, 35,000Å nominal. |
| 4. Back metal | A. Al/Ti/Ni/Ag 12kÅ/3kÅ/7kÅ/7kÅ minimal, 15kÅ/5kÅ/10kÅ/10kÅ nominal.
B. Gold 2500Å minimum, 3000Å nominal. |
| 5. Backside | Collector |
| 6. Bonding pad | B = .052 x .012 inches (1.32 mm x 0.30 mm).
E = .084 x .012 inches (2.13 mm x 0.30 mm). |

FIGURE 4. JANHCC and JANKCC die dimensions.



Symbol	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
BL	.395	.405	10.04	10.28
BW	.291	.301	7.40	7.64
CH	.1085	.1205	2.76	3.06
LH	.010	.020	0.25	0.51
LW1	.281	.291	7.14	7.41
LW2	.090	.100	2.29	2.54
LL1	.220	.230	5.59	5.84
LL2	.115	.125	2.93	3.17
LS1	.150 BSC		3.81 BSC	
LS2	.075 BSC		1.91 BSC	
Q1	.030	---	0.762	---
Q2	.030	---	0.762	---
TERM 1	Drain			
TERM 2	Gate			
TERM 3	Source			

NOTES:

1. Dimensions are in inches.
2. Metric equivalents are given for general information only.
3. Dimensions and tolerances shall be in accordance with ASME Y14.5M.
4. Terminal 1 - collector, terminal 2 - base, terminal 3 - emitter.

SCHEMATIC

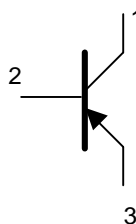


FIGURE 5. Physical dimensions and configuration for surface mount (U3).

3. REQUIREMENTS

3.1 General. The individual item requirements shall be as specified in MIL-PRF-19500 and as modified herein.

3.2 Qualification. Devices furnished under this specification shall be products that are manufactured by a manufacturer authorized by the qualifying activity for listing on the applicable qualified manufacturer's (QML list) before contract award (see 4.2 and 6.3).

3.3 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in MIL-PRF-19500.

3.4 Interface and physical dimensions. The interface and physical dimensions shall be as specified in MIL-PRF-19500 and figure 1 (Similar to T0-5 and T0-39), and figures 2, 3, 4 (die dimensions) for JANHC and JANKC, and figure 5 (U3)

3.4.1 Current density. Current density of internal conductors shall be as specified in MIL-PRF-19500.

3.4.2 Lead finish. Lead finish shall be solderable as defined in MIL-PRF-19500, MIL-STD-750, and herein. Where a choice of lead finish is desired, it shall be specified in the acquisition document (see 6.2).

3.5 Electrical performance characteristics. Unless otherwise specified herein, the electrical performance characteristics are as specified in 1.3, 1.4, and table I herein.

3.6 Electrical test requirements. The electrical test requirements shall be the subgroups specified in table I herein.

3.7 Marking. Marking shall be in accordance with MIL-PRF-19500.

3.8 Workmanship. Semiconductor devices shall be processed in such a manner as to be uniform in quality and shall be free from other defects that will affect life, serviceability, or appearance.

4 VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

- a. Qualification inspection (see 4.2).
- b. Screening (see 4.3).
- c. Conformance inspection (see 4.4).

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-PRF-19500 and as specified herein.

4.2.1 JANHC and JANKC qualification. JANHC and JANKC qualification inspection shall be in accordance with MIL-PRF-19500.

* 4.2.2 Group E qualification. Group E qualification shall be performed herein for qualification or requalification only. In case qualification was awarded to a prior revision of the associated specification that did not request the performance of table III tests specified in table III herein shall be performed by the first inspection lot to this revision to maintain qualification.

4.3 Screening (JANS, JANTX, and JANTXV levels only). Screening shall be in accordance with table IV of MIL-PRF-19500 and as specified herein. The following measurements shall be made in accordance with table I herein. Devices that exceed the limits of table I herein shall not be acceptable.

*

Screen (see table IV of MIL-PRF-19500)	Measurement	
	JANS levels	JANTX and JANTXV levels
1a 1b	Not required Required	Not required Required for JANTXV only
2	Optional	Optional
3a 3b 3c	Required Not applicable Thermal response, method 3131 of MIL-PRF-19500.	Required Not applicable Thermal response, method 3131 of MIL-PRF-19500.
4	Required	Optional
5	Required	Not applicable
7a and 7b	Optional	Optional
8	Required	Not required
9	I_{CES1} and h_{FE2}	Not applicable
10	48 hours minimum	48 hours minimum
11	I_{CES1} and h_{FE2} ; ΔI_{CES1} = 100 percent of initial value or 100 nA dc, whichever is greater. Δh_{FE2} = ± 20 percent.	I_{CES1} and h_{FE2}
12	See 4.3.2	See 4.3.2
13	Subgroup 2 and 3 of table I herein; ΔI_{CES1} = 100 percent of initial value or 100 nA dc, whichever is greater. Δh_{FE2} = ± 20 percent.	Subgroup 2 of table I herein; ΔI_{CES1} = 100 percent of initial value or 100 nA dc, whichever is greater. Δh_{FE2} = ± 20 percent.
14a and 14b	Required	Required
15	Required	Not required
16	Required	Not required

* 4.3.1 Screening (JANH and JANKC). Screening of JANHC and JANKC die shall be in accordance with MIL-PRF-19500 Discrete Semiconductor Die/Chip Lot Acceptance. Burn-in duration for the JANKC level follows JANS requirements; the JANHC follows JANTX requirements.

* 4.3.2 Power burn-in conditions. Power burn-in conditions are as follows: $V_{CB} = 10$ Vdc, T_A = room ambient as defined in the general requirements of 4.5 of MIL-STD-750. Power shall be applied to the device to achieve a Junction temperature, $T_J = +175^\circ\text{C}$ minimum and a minimum $P_D = 75$ percent of P_T maximum rated as defined in 1.3 herein.

4.4 Conformance inspection. Conformance inspection shall be as specified herein.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with MIL-PRF-19500 and table I herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein.

4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the test and conditions specified for subgroup testing in table VIa (JANS) and table VIb (JAN, JANTX, and JANTXV) of MIL-PRF-19500 and 4.4.2.1 and 4.4.2.2 herein. Electrical measurements (end-points) shall be in accordance with table I, subgroup 2 herein. Delta measurements shall be in accordance with table II herein.

* 4.4.2.1 Group B inspection (JANS) table VIa of MIL-PRF-19500.

<u>Subgroup</u>	<u>Method</u>	<u>Conditions</u>
B4	1037	$V_{CB} = 10 - 30$ Vdc.
B5	1027	(Note: If a failure occurs, resubmission shall be at the test conditions of the original sample). $V_{CB} = 10$ V dc; $P_D \geq 100$ percent of maximum rated P_T (see 1.3). $T_A \leq 35^\circ\text{C}$. Option 1: 96 hours minimum, sample size in accordance with table VIa of MIL-PRF-19500, adjust P_D to achieve $T_J = +275^\circ\text{C}$ minimum. Option 2: 216 hours., sample size = 45, $c = 0$; adjust P_D to achieve $T_J = +225^\circ\text{C}$ minimum.
B6	3131	See 4.5.2.

* 4.4.2.2 Group B inspection, (JAN, JANTX, and JANTXV). Separate samples may be used for each step. In the event of a group B failure, the manufacturer may pull a new sample at double size from either the failed assembly lot or from another assembly lot from the same wafer lot. If the new "assembly lot" option is exercised, the failed assembly lot shall be scrapped.

<u>Step</u>	<u>Method</u>	<u>Conditions</u>
1	1039	Steady-state life: Test condition B, 340 hours min., $V_{CB} = 10$ V dc, power shall be applied to achieve $T_J = +175^\circ\text{C}$ minimum using a minimum of $P_D = 75$ percent of maximum rated P_T as defined in 1.3. $n = 45$ devices, $c = 0$.
* 2	1039	HTRB test condition A; 48 hours minimum. $n = 45$, $c = 0$.
3	1039	The steady-state life test of step 1 shall be extended to 1,000 Hrs for each die design. Samples shall be selected from a wafer lot every twelve months of wafer production. Group B, step 2 shall not be required more than once for any single wafer lot. $n = 45$, $c = 0$.
4	1032	High-temperature life (non-operating), $t = 340$ hours, $T_A = +200^\circ\text{C}$. $n = 22$, $c = 0$.

4.4.2.3 Group B sample selection. Samples selected from group B inspection shall meet all of the following requirements:

- a. For JAN, JANTX, and JANTXV samples shall be selected randomly from a minimum of three wafers (or from each wafer in the lot) from each wafer lot. See MIL-PRF-19500.
- b. Must be chosen from an inspection lot that has been submitted to and passed group A, subgroup 2, conformance inspection. When the final lead finish is solder or any plating prone to oxidation at high temperature, the samples for life test (group B for JAN, JANTX, and JANTXV) may be pulled prior to the application of final lead finish.

4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the tests and conditions specified for subgroup testing in table VII of MIL-PRF-19500, and 4.4.3.1 (JANS), and 4.4.3.2 (JAN, JANTX, and JANTXV) herein for group C testing. Electrical measurements (end-points) and delta requirements shall be in accordance with table I, subgroup 2 and 4.5.6 herein.

* 4.4.3.1 Group C inspection, table VII (JANS) of MIL-PRF-19500.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
C2	2036	Test condition E (not applicable to UA and UB devices).
C6	1026	1,000 hours at $V_{CB} = 10$ V dc; power shall be applied to achieve $T_J = 150^\circ\text{C}$ minimum and a minimum of $P_d = 75$ percent of maximum rated P_d as defined in 1.3.

4.4.3.2 Group C inspection, table VII (JAN, JANTX, and JANTXV) of MIL-PRF-19500.

<u>Subgroup</u>	<u>Method</u>	<u>Condition</u>
* C2	2036	Test condition E (not applicable to UA and UB devices).
C5	3131	$R_{\theta JA}$ (see 1.3).
C6	1037	Not applicable.

* 4.4.4 Group E inspection. Group E inspection shall be conducted in accordance with the conditions specified for subgroup testing in appendix E, table IX of MIL-PRF-19500 and as specified herein.

4.5 Methods of inspection and test. Methods of inspection and test shall be as specified in the appropriate tables and as follows:

4.5.1 Pulse measurements. Conditions for pulse measurements shall be as specified in section 4 of MIL-STD-750.

4.5.2 Thermal resistance. Thermal resistance measurements shall be conducted in accordance with method 3131 of MIL-STD-750. The following details shall apply:

- a. Collector current magnitude during power application shall be 500 mA dc minimum.
- b. Collector to emitter voltage magnitude shall be 10 V dc.
- c. Reference temperature measuring point shall be the case.
- d. Reference temperature measuring point shall be within the range $+25^\circ\text{C} \leq T_R \leq +35^\circ\text{C}$. The chosen reference temperature shall be recorded before the test is started.
- e. Mounting arrangement shall be with heat sink to case.
- f. Maximum limit of $R_{\theta JC}$ shall be 15.0°C/W for (TO-5, and TO-39) and 1.75°C/W for U3.

TABLE I. Group A inspection.

Inspection 1/ <u>Subgroup 1</u> 2/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Visual and mechanical examination 3/	2071	n = 45 devices, c = 0				
Solderability 3/ 4/	2026	n = 15 leads, c = 0				
Resistance to solvents 3/ 4/ 5/	1022	n = 15 devices, c = 0				
Temp Cycling 3/ 4/	1051	Test condition C, 25 cycles. n = 22 devices, c = 0				
Electrical measurements 4/		Group A, subgroup 2				
Hermetic Seal 4/ 6/	1071	n = 22 devices, c = 0				
Fine leak Gross leak						
Bond strength 3/ 4/	2037	Precondition $T_A = +250^\circ\text{C}$ at $t = 24$ hrs or $T_A = +300^\circ\text{C}$ at $t = 2$ hrs n = 11 wires, c = 0				
<u>Subgroup 2</u>						
Breakdown voltage, collector to emitter	3011	Bias condition D, $I_C = 100$ mA dc; $I_B = 0$, Pulsed (see 4.5.1)	$V_{(BR)CEO}$	80		V dc
Collector to emitter cutoff current	3041	Bias condition C, $V_{CE} = 60$ V dc; $V_{BE} = 0$	I_{CES1}		1.0	μA dc
Collector to emitter cutoff current	3041	Bias condition C, $V_{CE} = 100$ V dc; $V_{BE} = 0$	I_{CES2}		1.0	mA dc
Collector to emitter cutoff current	3041	Bias condition D, $V_{CE} = 40$ V dc, $I_B = 0$	I_{CEO}		50	μA dc
Emitter to base cutoff current	3061	Bias condition D, $V_{EB} = 4$ V dc, $I_C = 0$	I_{EBO1}		1.0	μA dc
Emitter to base cutoff current	3061	Bias condition D, $V_{EB} = 5.5$ V dc, $I_C = 0$	I_{EBO2}		1.0	mA dc

See footnotes at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/ <u>Subgroup 2 - Continued.</u>	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Forward current transfer ratio 2N5152 2/ 2N5154	3076	$V_{CE} = 5 \text{ V dc}, I_C = 50 \text{ mA dc}$	h_{FE1}	20 50		
Forward current transfer ratio 2N5152 2/ 2N5154	3076	$V_{CE} = 5 \text{ V dc}, I_C = 2.5 \text{ A dc, pulsed}$ (see 4.5.1)	h_{FE2}	30 70	90 200	
Forward current transfer ratio 2N5152 2/ 2N5154	3076	$V_{CE} = 5 \text{ V dc}, I_C = 5 \text{ A dc, pulsed}$ (see 4.5.1)	h_{FE3}	20 40		
Base-emitter voltage (nonsaturated)	3066	Test condition B, $V_{CE} = 5 \text{ V dc},$ $I_C = 2.5 \text{ A dc, pulsed}$ (see 4.5.1)	V_{BE}		1.45	V dc
Base-emitter saturation voltage	3066	Test condition A, $I_C = 2.5 \text{ A dc},$ $I_B = 250 \text{ mA dc, pulsed}$ (see 4.5.1)	$V_{BE(sat)1}$		1.45	V dc
Base-emitter saturation voltage	3066	Test condition A, $I_C = 5 \text{ A dc},$ $I_B = 500 \text{ mA dc, pulsed}$ (see 4.5.1)	$V_{BE(sat)2}$		2.2	V dc
Collector-emitter saturation voltage	3071	$I_C = 2.5 \text{ A dc}, I_B = 250 \text{ mA dc},$ pulsed (see 4.5.1)	$V_{CE(sat)1}$		0.75	V dc
Collector-emitter saturation voltage	3071	$I_C = 5 \text{ A dc}, I_B = 500 \text{ mA dc, pulsed}$ (see 4.5.1)	$V_{CE(sat)2}$		1.5	V dc
<u>Subgroup 3</u>						
High temperature operation:		$T_C = +150^\circ\text{C}$				
Collector to emitter cutoff current	3041	Bias condition A, $V_{CE} = 60 \text{ V dc},$ $V_{BE} = -2 \text{ V dc}$	I_{CEX}		100	$\mu\text{A dc}$
Low temperature operation		$T_C = -55^\circ\text{C}$				

See footnotes at end of table.

TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 3</u> – Continued						
Forward - current transfer ratio 2N5152 <u>2/</u> 2N5154	3076	$V_{CE} = 5 \text{ V dc}$, $I_C = 2.5 \text{ A dc}$, pulsed (see 4.5.1)	h_{FE4}	15 25		
<u>Subgroup 4</u>						
Common-emitter, small-signal, short-circuit, forward-current transfer ratio 2N5152 <u>2/</u> 2N5154	3206	$V_{CE} = 5 \text{ V dc}$, $I_C = 100 \text{ mA dc}$, $f = 1 \text{ kHz}$	h_{fe}	20 50		
Magnitude of common-emitter, small-signal short-circuit, forward-current, transfer ratio 2N5152 <u>2/</u> 2N5154	3306	$V_{CE} = 5 \text{ V dc}$, $I_C = 500 \text{ mA dc}$, $f = 10 \text{ MHz}$	$ h_{fe} $	6 7		
Open-circuit output capacitance	3236	$V_{CB} = 10 \text{ V dc}$, $I_E = 0$, $f = 1 \text{ MHz}$	C_{obo}		250	pf
Switching time		$I_C = 5 \text{ A dc}$, $I_{B1} = 500 \text{ mA dc}$	t_{on}		0.5	μs
		$I_{B2} = -500 \text{ mA dc}$	t_s		1.4	μs
		$V_{BE(off)} = 3.7 \text{ V dc}$	t_f		0.5	μs
		$R_L = 6\Omega$; (See figure 6)	t_{off}		1.5	μs
<u>Subgroup 5</u>						
Safe operating area (d.c.)	3051	Pre-pulse condition for each test: $T_C = +25^\circ\text{C}$ Pulse condition for each test $t_p = 1 \text{ sec. 1 cycle}$, $T_C = +25^\circ\text{C}$, (see figure 7)				
* Test # 1		$V_{CE} = 5.0 \text{ V dc}$, $I_C = 2 \text{ A dc}$ for TO39, TO5, U3				

See footnotes at end of table.

TABLE I Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
<u>Subgroup 5 –continued</u> * Test # 2 * Test # 3 Safe operating area (unclamped inductive) End-point electrical measurements <u>Subgroups 6 and 7</u> Not applicable		$V_{CE} = 32 \text{ V dc}, I_C = 310 \text{ mA dc.}$ $V_{CE} = 80 \text{ V dc}, I_C = 12.5 \text{ mA dc.}$ $T_C = +25^\circ\text{C}, R_{BB1} = 10\Omega$ $R_{BB2} = 100\Omega, L = 0.3 \text{ mH},$ $RL = 0.1\Omega, V_{CC} = 10 \text{ V dc},$ $V_{BB1} = 10 \text{ V dc}, V_{BB2} = 4 \text{ V dc},$ $I_{CM} = 10 \text{ A dc, (see figure 8)}$ See table I, subgroup 2				

1/ For sampling plan see MIL-PRF-19500.

2/ For resubmission of failed subgroup A1, double the sample size of the failed test or sequence of tests. A failure in group A, subgroup 1 shall not require retest of the entire subgroup. Only the failed test shall be rerun upon submission.

3/ Separate samples may be used.

4/ Not required for JANS devices.

5/ Not required for laser marked devices.

*6/ Hermetic seal test is an end-point to temperature cycling in addition to electrical measurements.

TABLE II. Group E inspection (all quality levels) – for qualification only.

*

Inspection	MIL-STD-750		Qualification
	Method	Conditions	
<u>Subgroup 1</u>			45 devices c = 0
Temperature cycling (air to air)	1051	Test condition C, 500 cycles	
Hermetic seal			
Fine leak	1071		
Gross leak			
Electrical measurements		See table I, subgroup 2 and table III herein.	
<u>Subgroup 2</u>			45 devices c = 0
Intermittent life	1037	V _{CB} = 10 V dc, 6,000 cycles.	
Electrical measurements		See table I, subgroup 2 and table III herein.	
<u>Subgroup 3</u>			
Not applicable			
*			
<u>Subgroup 4</u>			22 devices c = 0
Thermal impedance	3131	Suppliers shall submit thermal impedance curves to the qualifying activity.	
<u>Subgroup 5, 6 and 7</u>			
Not applicable			
<u>Subgroup 8</u>			45 devices c = 0
Reverse stability	1033	Condition A for devices ≥ 400 V Condition B for devices < 400 V	

TABLE III. Groups B, C and E delta electrical measurements. 1/ 2/ 3/

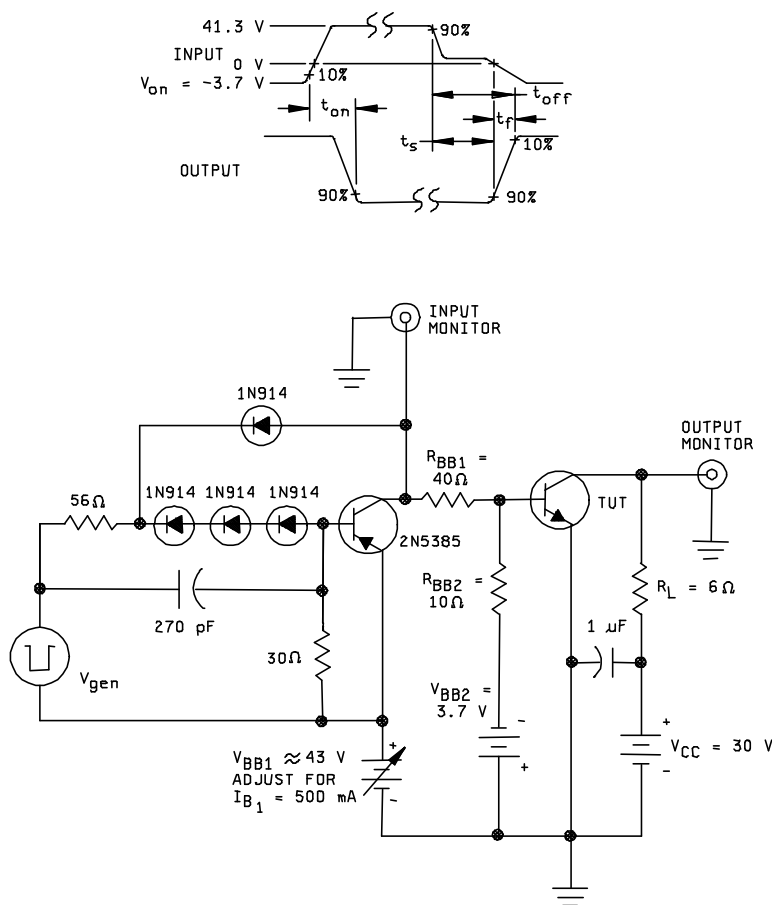
Step	Inspection	MIL-STD-750		Symbol	Limits		Unit
		Method	Conditions		Min	Max	
1.	Forward - current transfer ratio	3076	$I_C = 2.5 \text{ A dc}$, $V_{CE} = 5 \text{ V dc}$, Pulsed (see 4.5.1)	Δh_{FE2}	$\pm 20\text{percent}$ change from initial reading.		

1/ The delta measurements for table VIa (JANS) of MIL-PRF-19500 are as follows: Subgroups 4 and 5, see table II herein, step 1.

2/ The delta measurements for table VIb (JAN, JANTX and JANTXV) of MIL-PRF-19500 are as follows: All subgroups, see table II herein, step 1.

3/ The delta measurements for table VII of MIL-PRF-19500 are as follows: Subgroup 6, see table II herein, step 1.

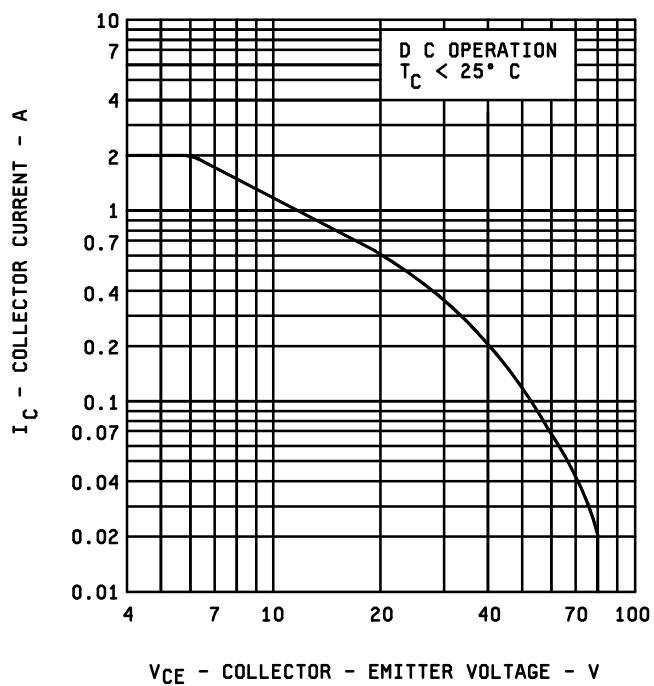
4/ The delta measurements for table II herein are as follows: Subgroups 1 and 2, see table II herein, step 1.



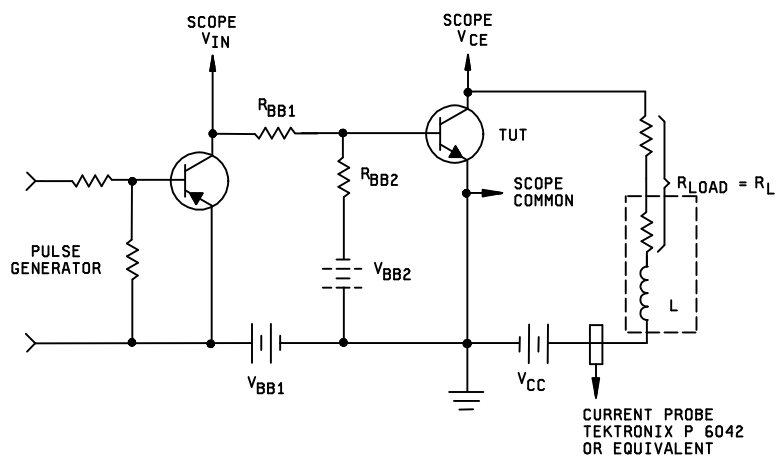
NOTES:

1. V_{gen} is a -30 pulse (from 0 V) into a 50 ohm termination.
2. The V_{gen} waveform is supplied by a generator with the following characteristics: $t_r \leq 15$ ns, $t_f \leq 15$ ns, $Z_{out} = 50$ ohm, duty cycle $\leq 2\%$, $t_w = 20$ μ s.
3. Waveforms are monitored on an oscilloscope with the following characteristics: $t_r \leq 1$ ns, $R_{in} \geq 10$ M ohm, $C_{in} \leq 11.5$ pF.
4. Resistors must be noninductive types.
5. The dc power supplies may require additional bypassing in order to minimize ringing.
6. An equivalent drive circuit may be used

FIGURE 6. Switching time test circuit.

FIGURE 7. Maximum safe operating area.

$R_{BB1} = 10\Omega$
 $R_{BB2} = 100\Omega$
 $L = 0.3 \text{ mH}$
 $R_L = 0.1\Omega$
 $V_{CC} = 10 \text{ V dc}$
 $I_{CM} = 10 \text{ A}$
 $V_{BB1} = 10 \text{ V dc}$
 $V_{BB2} = 4 \text{ V dc}$

FIGURE 8. Unclamped inductive load energy test circuit.

5. PACKAGING

5.1. Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Points' packaging activity within the Military Department or Defense Agency, or within the Military Departments' System Command. Packaging data retrieval is available from the managing Military Departments' or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The notes specified in MIL-PRF-19500 are applicable to this specification.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of this specification.
- b. Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.2.1).
- c. The lead finish as specified (see 3.4.2).
- d. Type designation and quality assurance level.
- e. Packaging requirements (see 5.1).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Manufacturers List (QML-19500) whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from Defense Supply Center, Columbus, ATTN: DSCC-VQE, P.O. Box 3990, Columbus, OH 43216-5000.

6.4 Suppliers of JANHC and JANKC die. The qualified JANHC and JANKC suppliers with the applicable letter version (example JANHCA2N5152) will be identified on the QML.

JANHC and JANKC ordering information			
PIN	Manufacturer		
	33178	34156	43611
2N5152 2N5154	JANHCA2N5152 JANHCA2N5154	JANHCB2N5152 JANHCB2N5154	JANHCC2N5152 JANHCC2N5154
2N5152 2N5154	JANKCA2N5152 JANKCA2N5154	JANKCB2N5152 JANKCB2N5154	JANKCC2N5152 JANKCC2N5154

6.5 Changes from previous issue. The margins of this revision are marked with an asterisk to indicate where changes from the previous amendment were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous amendment.

Custodians:
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Air Force - 11
NASA - NA
DLA – CC

Preparing activity:
DLA – CC

(Project 5961-2529)

Review activity:
Navy - MC
Air Force – 19, 71

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I RECOMMEND A CHANGE:

1. DOCUMENT NUMBER
MIL-PRF-19500/544E

2. DOCUMENT DATE
13 March 2003

3. DOCUMENT TITLE

SEMICONDUCTOR DEVICE, TRANSISTOR, NPN, SILICON, POWER TYPES 2N5152, 2N5154, 2N5152L, 2N5154L, 2N5152U3 2N5154U3 JAN, JANTX, JANTXV, JANS, JANHC, AND JANKC

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

5. REASON FOR RECOMMENDATION**6. SUBMITTER**

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8. PREPARING ACTIVITY

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